Why food processing matters to understand diet and health in the 21st century
(with an emphasis on epidemiological evidence)

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Why food processing matters to understand diet and health in the 21st century

• Diet and health: a complex relationship

• The role of food processing on this relationship

• Evidence on the impact of ultra-processed foods on diet quality and health

• Policy implications
Narrow and broad views of health

*Health as the mere absence of disease*

-vs.-

*Health as a state of complete physical, mental and social well-being*

*Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19 June - 22 July 1946*
There is also a narrow view on diet …
For ‘nutritionism’, Soylent would be an option for ‘healthy diets’
HOW SOYLENT WORKS
Soylent vs. Food

Based on a 30-year-old man,
6 feet, 165 pounds, physically active
30 to 60 minutes a day

Soylent

1 powdered pouch = 2,000 calories (2 scoops)
1/4 pouch = 500 calories = 1 meal

What’s in it?
Brown rice, oat flour,
sucrose, potato starch, rice
starch, cellulose, sucrose, high
oleic sunflower oil, soy lecithin,
flaxseed, safflower oil, algal oil,
blend of vitamins and minerals.

Food

Daily plan of 2,800 calories

Grains: 10 ounces
Bread, pasta, cereals

Vegetables: 3.5 cups
Dark leafy greens, beans, peas, lentils,
potatoes, corn, tomao, squash, carrots,
peppers

Fruits: 2.5 cups
Apples, melons,
berrys, citrus, and
100% fruit juice

Dairy: 3 cups
Milk, cheese, ice cream,
yogurt

Protein: 7 ounces
Meats, poultry, eggs, beans,
fish, nuts

Carbohydrates
51 grams
(4 grams fiber,
11 grams sugar)

Fat
24 grams
(3 grams saturated fat)

Protein
21 grams
Plus micronutrients like,
Potassium, Vitamin C,
Copper, Sodium, Calcium
Four elements in diet influence health:

Nutrients

Foods (more than nutrients!)

Meals (more than foods!)

Eating modes (when, where, how?)
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Food processing within the food system

Food Production (Agriculture) → Unprocessed foods → Food processing (Industry) → Processed foods → Food Preparation/Cooking (Kitchen)

Diet

Food processing within the food system

Processed foods

Unprocessed foods
What is the purpose of food processing?
Food processing to increase **food** duration, to make easier/more diverse **food** preparation, or to modify/enhance **food** sensorial properties.
Processes used in the manufacture of NOVA groups 1 to 3

- Food Production (Agriculture) → Unprocessed foods
- Food processing (Industry) → Minimally processed foods, Processed culinary Ingredients, Processed foods
- Food Preparation/Cooking (Kitchen) → Diet made of fresh foods and freshly-prepared dishes, drinks and meals

Removal of non-edible or undesired parts, drying, chilling, freezing, pasteurization, fermentation, boiling, baking, milling, pressing, centrifuging, salting, sugaring...
Food processing aiming convenient (ready-to-eat or heat, imperishable), low cost, and tasteful products liable to replace all other NOVA groups.
Food processing aiming convenient (ready-to-eat or heat, imperishable), relatively cheap and tasteful products liable to replace all other NOVA groups.
Ultra-processed foods are manufactured and marketed to replace fresh foods and freshly prepared drinks, dishes and meals.
What processes are involved with food ultra-processing?

Food Production (Agriculture) → Unprocessed foods → Food ultra-processing (Industry) → Ultra-processed foods

- Extraction of oils/fats/sugar/starches/protein contained in foods
- Chemical modifications of substances obtained from foods (hydrogenation …)
- Assembly of unmodified and modified food substances (extrusion, deep frying …)
- Use of cosmetic additives (flavours, colours, emulsifiers …)
- Sophisticated packaging often using synthetic materials.

Food Preparation/Cooking (Kitchen)
Most basic ingredients of ultra-processed foods come from a few-high yield plant foods and intensive livestock farming.

Unprocessed foods → Food ultra-processing (Industry) → Ultra-processed foods → Food Preparation/Cooking (Kitchen)

Extraction of **oils/sugar/starches/protein** contained in foods

- Chemical modifications of substances obtained from foods
- Assembly of unmodified and modified food substances
- Use of cosmetic additives (flavours, colours, emulsifiers …)
- Sophisticated packaging often using synthetic materials.
NOVA group 4 favors unhealthy eating modes.

Food Production (Agriculture) → Unprocessed foods → Ultra-food processing (Industry) → Ultra-processed food and drink products → Food Preparation/Cooking (Kitchen)
NOVA groups 1 to 3 favor healthy eating modes

Food Production (Agriculture) → Unprocessed foods → Food processing (Industry) → Food Preparation/Cooking (Kitchen)
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### NOVA food groups

<table>
<thead>
<tr>
<th>NOVA food groups</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Unprocessed or minimally processed foods</td>
<td><img src="image1" alt="Examples" /></td>
</tr>
<tr>
<td>2) Processed culinary ingredients</td>
<td><img src="image2" alt="Examples" /></td>
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<tr>
<td>3) Processed foods</td>
<td><img src="image3" alt="Examples" /></td>
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<tr>
<td>4) Ultra-processed foods</td>
<td><img src="image4" alt="Examples" /></td>
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</tbody>
</table>

**4) Ultra-processed foods**

Formulations resulting from a sequence of processes that include the fractioning of whole foods into substances, the modification and recombination of these substances, use of cosmetic additives, and often sophisticated packaging, all aiming to obtain durable, ready-to-consume, hyper-palatable, and highly profitable products with potential to replace all other food groups.

Articles in PubMed with the term ‘ultra-processed’

(Only January-July)
Why food processing matters to understand diet and health in the 21st century

• The impact of ultra-processed foods on:
  • Diet quality
  • NCDs
Dietary share of ultra-processed foods in 8 countries (% of total energy intake)
Quintiles (Q) of the dietary share of ultra-processed foods (% of total energy intake)

<table>
<thead>
<tr>
<th>Country</th>
<th>Q1</th>
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<th>Q3</th>
<th>Q4</th>
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</tbody>
</table>
Diet quality according to quintiles of ultra-processed food intake
NOVA multi-country study, 2005-2014.
Diet quality according to quintiles of ultra-processed food intake
NOVA multi-country study, 2005-2014.

Free sugar (% total energy intake)

Ultra-processed food (% total energy intake)

WHO dietary upper limit
Diet quality according to quintiles of ultra-processed food intake
NOVA multi-country study, 2005-2014.
Potentially harmful UPF attributes other than their unbalanced nutrient profile

- ‘Acellular’ nutrients and additives and their effect on microbiome (Zinocker & Lindseth 2018)
- Absence or low concentration of bioactive compounds (Martinez-Steele & Monteiro 2017)
- High glycemic index and low satiety (Fardet 2016)
- Hyper-palatability (Kessler 2009; Brownell 2012; Moss 2013; Ifland 2018)
- Mindless eating (Cohen & Farley 2008)
- Aggressive and sophisticated marketing
Why food processing matters to understand diet and health in the 21st century

• The impact of ultra-processed foods on:
  – Diet quality
  – NCDs
Hierarchy of designs for cause-probing research questions*

- Generate hypothesis (bias ++)
- Internal validity
- Establish causality (bias --)

1. RCT
2. Longitudinal studies
3. Cross-sectional studies

Adapted from www.cebma.org/faq/what-are-the-levels/of/evidence
Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake

Graphical Abstract

Authors
Kevin D. Hall, Alexis Ayuketah, Robert Brychta, ..., Peter J. Walter, Shanna Yang, Megan Zhou

Correspondence
kevinh@nih.gov

In Brief
Hall et al. investigated 20 inpatient adults who were exposed to ultra-processed versus unprocessed diets for 14 days each, in random order. The ultra-processed diet caused increased ad libitum energy intake and weight gain despite being matched to the unprocessed diet for presented calories, sugar, fat, sodium, fiber, and macronutrients.
Overview of the study design. Twenty adults were confined to metabolic wards where they were randomized to consume either an ultra-processed or unprocessed diet for 2 consecutive weeks followed immediately by the alternate diet.
Ultra-processed Menu

Day 2

Breakfast
Croissant (Chef Pierre)
Margarine (Glenview Farms)
Turkey sausage (Ember Farms)
Blueberry yogurt (Yoplait) with NutriSource fiber

Non ultra-processed Menu

Day 2

Breakfast
Scrambled egg (made from fresh eggs)
Hash brown potatoes (potato, garlic, paprika (Simply Organic), ground turmeric (McCormick), cream (Stoneyfield) and onions)
Salt and Pepper (Monarch)
Ultra-processed Menu

Day 4
Lunch
Hot dog (Patuxent Farms) on bun (Hilltop Hearth) with ketchup (Heinz) and yellow mustard (Monarch)
Baked potato chips (Lay's)
Cranberry juice (Sun Cup) with NutriSource fiber
Blueberry yogurt (Yoplait) with NutriSource fiber

Non ultra-processed Menu

Day 4
Lunch
Baked cod filet (Harbor Banks) with fresh squeezed lemon juice
Baked russet potato with olive oil
Steamed broccoli with olive oil and garlic
Side salad (green leaf lettuce, tomatoes, cucumber and carrots)
Vinaigrette (balsamic vinegar (Nature’s Promise) and olive oil)
Salt and Pepper (Monarch)
Ultra-processed Menu

Day 7

Dinner
Peanut butter (Monarch) and jelly (Monarch) sandwich on white bread (Ottenberg)
2% milk (Cloverland) with NutriSource fiber
Baked Cheetos (Frito-Lay)
Graham crackers (Nabisco)
Chocolate pudding (Snack Pack) with NutriSource fiber

Non ultra-processed Menu

Day 7

Dinner
Penne pasta (Barilla) primavera (olive oil, garlic, pinto beans (cooked from dried), spinach, basil, tomatoes)
Side salad (green leaf lettuce, baby carrots, broccoli)
Vinaigrette (red wine vinegar (Giant) and olive oil)
Salt and Pepper (Monarch)
Grapes
Ultra-processed Menu

Daily Snacks
Baked Potato Chips (Lay’s), Dry Roasted Peanuts (Planters), Cheese & Peanut Butter Sandwich Crackers (Keebler), Goldfish Crackers (Pepperidge Farm), Applesauce (Lucky Leaf).

Non ultra-processed Menu

Daily Snacks
Fresh oranges and apples, raisins (Monarch), raw almonds (Giant), chopped walnuts (Diamond)
A) Energy intake was consistently higher during the ultra-processed diet. B) Average energy intake was increased during the ultra-processed diet because of increased intake of carbohydrate and fat, but not protein.
Differences in body weight change between the ultra-processed and unprocessed diets were highly correlated with the corresponding energy intake differences.
Are UPF harmful because of their unbalanced nutrient profile, or because ‘acellular nutrients’, or because of the way they are consumed, or because of additives, or because their effects on the microbiome, or ...?
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Actions and policies that are not working:

- Nutrient-based guides and education
- Misleading nutritional labelling
- Cosmetic product reformulation
- Marketing self-regulation
The real best buys:
Diet guides and nutrition education that promote real food and real meals
Fiscal policies that make real food and real meals more affordable than UPF
Warning labels and strong marketing restrictions on ALL UPF
A global framework convention on food systems
Many thanks!